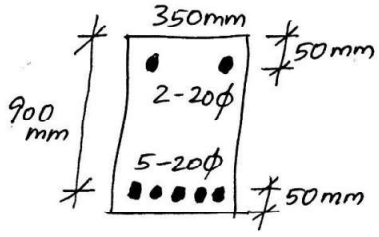
Q6. Determine moment of resistance of a beam having 350 mm width, 900 mm effective depth and 50 mm effective cover. The beam has 5 nos of 20 mmϕ tension reinforcements and 2 nos. of 20 mmϕ compression reinforcements. Use M15 concrete and Fe 415 steel.

Ans:



We know

$$C_c = \cancel{0.45 f_{ck}}\ 0.36 f_{ck} b x_u$$

$$C_s = f_{sc} A_{sc} - 0.45 f_{ck} A_{sc}$$

$$T = 0.87 f_y A_{st}$$

Since $C_c + C_s = T$

$$\Rightarrow x_u = \frac{0.87 f_y A_{st} - f_{sc} A_{sc} + 0.45 f_{ck} A_{sc}}{0.36 f_{ck} b}$$

where $f_y = 415\ N/mm^2$

$A_{st} = 5 \pi/4 \times 20^2$

$A_{sc} = 2\pi/4 \times 20^2$

$f_{ck} = 15\ N/mm^2$

$b = 350\ mm$

$d'/d = \frac{50}{900} = 0.055$

We know,
for $d'/d = 0.05 \rightarrow f_{sc} = 355$
for $d'/d = 0.10 \rightarrow f_{sc} = 353$

$\Rightarrow f_{sc} = 354.8\ N/mm^2$

$$= 355 + \frac{(353-355)(0.055-0.05)}{(0.10-0.05)}$$

$$\therefore x_u = \frac{(0.87 \times 415 \times 5\pi/4 \times 20^2) - (354.80 \times 2\pi/4 \times 20^2) + (0.45 \times 15 \times 2\pi/4 \times 20^2)}{0.36 \times 15 \times 350}$$

$$= 184.37 \text{ mm}$$

$x_{u,max} = 0.48d$ (For fe415)

$= 0.48 \times 900 = 432$ mm

Since $x_u < x_{umax}$

$\Rightarrow$ the section is underreinforced.

$\therefore$ Moment of Resistance of the section

$= C_c (d - 0.42 x_u) + C_s (d - d')$

$= [(0.36 \times 15 \times 350 \times 184.37)(900 - 0.42 \times 184.37)]$

$+$

$[(354.80 \times 2\pi/4 \times 20^2 - 0.45 \times 15 \times 2\pi/4 \times 20^2)(900 - 50)]$

$= (286.63 + 185.88) \times 10^6$

$= 472.51$ kNm